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XII.—*On a remarkable Form of Pedicellaria, and the Functions performed thereby; together with General Observations on the Allied Forms of this Organ in the* Echinidæ.

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[Plates XII. & XIII.]

The following peculiarities in the structure of certain pedicellariæ appear to have been undescribed.

In *Sphærechinus granularis* (Lamk.), A. Ag., the *pedicellariæ globiferæ* * are very much larger than the other forms of pedicellaria upon the same animal, and are of enormous size when compared with the usual relative proportions of this appendage in other species of *Echini*. The special fea-

* I am unwilling to follow those writers who ignore altogether the old names by which the different forms of pedicellariæ were originally described, and who anglicize the colloquial French terms applied by Valentin, although there can be no doubt whatever about the special form to which each of Müller's terms belonged, the figures and descriptions given in the 'Zoologia Danica' being perfectly recognizable and characteristic. The following tabulation of the original nomenclature and the subsequent one used by the French *savants* will save much tedious reference :—

Pedicellaria, O. F. Müller (Zool. Dan.).

O. F. Müller (1788).		Valentin (1841).		Perrier (1869).
P. globifera	=	p. gemmiforme	=	p. gemmiforme.
P. triphylla	=	p. ophicéphale ou buccal	=	p. ophicéphale.
P. tridens	=	p. tridactyle	=	p. tridactyle.

ture to which I wish to draw attention is the presence of a remarkable glandular organ upon the stem or pedicel of the *ped. globiferæ* of *S. granularis*, situated between the middle portion of the shaft and the distal extremity to which the valvate head is attached. Normally the presence of this organ is superficially manifest as a conspicuous dilatation upon the shaft. When examined with a lens of low power the dilatation is found to possess a tripartite form, apparently in correspondence with the divisions of the head of the pedicellaria; and near the upper portion of each of the three sections or separate sacculi there is to be seen a small foramen or pore, through which a glairy mucous matter is extruded as occasion requires.

The discharge of mucus, it should here be mentioned, is not solely confined to these organs upon the stem; for a similar secretion is also copiously ejected from the saccular head of the *pedicellaria globifera*, under certain conditions which will hereafter be referred to.

These circumstances led the author, whilst studying at the Zoological Station at Naples, to pay some attention to the subject; and it is upon the notes and preparations there made that the present communication is in a large measure based.

When a specimen of *S. granularis* is placed in fresh water, the animal frequently throws off a considerable quantity of slime or mucus, as if in an endeavour to free itself from the obnoxious environment. This exudation is found to proceed from the *pedicellariæ globiferæ*; and, so far as I have been able to observe, I am disposed to think that its origin is referable entirely to these appendages. It may be remarked in passing, however, that this procedure is not confined to the species under notice, nor yet to the group of the "regular" Echinoidea; for *Echinocardium* and some species of starfish may be seen to behave in a similar manner when subjected to the same treatment; indeed the discharge from the Spatangoid is much more copious than in the case of *S. granularis*.

The *pedicellariæ globiferæ* of *S. granularis* are readily distinguishable from the accompanying *ped. triphyllæ* and *ped. tridentes*, which are found upon the same test. Apart from their larger size, the head has the appearance of being fleshy and globose; and the jaw-pieces or valves are enveloped in large membranous sacs; whilst the distal extremity of the internal calcareous skeleton-frame is sharply bent at a right angle from the main axis of the jaw-piece, and attenuated into a long, sharp, tooth-like process or fang that protrudes from the saccular development just mentioned, and which, when the pedicellaria is closed, meets in the centre with the

corresponding processes of the companion jaw-pieces. The stem is rigid throughout, and contains a calcareous shaft that traverses the entire length, and to which the head of the pedicellaria is directly attached. Near the middle portion of the stem is the large, inflated, gibbous, sac-like swelling previously mentioned; and, considering its very prominent and conspicuous character, it seems surprising that its occurrence in this common Mediterranean species should not have been more generally observed.

The Glandular Sacculi of the Stem.—The description of the pedicellaria will commence most conveniently at this part. The sacculi of the stem-dilatation are generally disposed in an irregular subspiral manner round the shaft, the apices of the three being never, so far as I am aware, all equidistant from the extremity of the shaft. After removing the pedicellaria from the test and rendering the tissues sufficiently clear for the transmission of light, it will be apparent that each of the sacculi contains an elongate ovoid or subcordiform mass, the upper portion of which terminates at the pore. By this method of examination no vessels of any kind are seen to open into the internal masses, either from above or below, and they have the appearance of simply lying upon the central rod and being held in position by attachment around the foramen (Pl. XII. fig. 4).

On dissecting away a portion of the investing membrane the mass can be readily displaced from within the sacculus with a fine needle-point; and it then has the appearance of a white, spongy, reticulated substance with a denser central portion within and a number of moderately large, elongated pink cells distributed over its surface, and through the substance itself, external to the central mass (fig. 3). In order to arrive at the ultimate structure of this body recourse must be had to other methods of investigation. I have found that sections are unquestionably the best means of attaining this end, although it is a very difficult matter to cut them of the requisite thinness, in consequence of the hard and gritty character imparted to the inner mucous mass by the chemical action of the various preservative and staining reagents which it is necessary to employ. On account of the nature of the mucus, some fluids are altogether inapplicable; picro-sulphuric acid or fresh water may be cited as examples; and, indeed, so sensitive does the mucus appear to be, that even when specimens that have been preserved in alcohol for more than a year are placed in water, the sacculi swell to many times their normal size and burst in a few moments.

I have found it to be the most satisfactory method of pre-

paration to place the pedicellariæ, immediately after removal from the test, in alcohol of 70 per cent. acidulated with 2 per cent. of HCl; and then, when decalcification has been effected and all traces of the acid thoroughly removed by repeated washings, to stain in hæmatoxylin.

A transverse section through the stem-dilatation (Pl. XII. fig. 8) presents the following series of tissues:—

1. Epithelial nucleated cells of the investing membrane; 2. A neuro-muscular layer with granular fusiform cells distributed here and there; 3. Tissue with numerous large colourless cells; 4. A layer of large areolar spaces and gland-cells and ducts; 5. The central mass, composed of a very finely reticulated substance, densely filled up with mucous matter (Pl. XII. fig. 8). A longitudinal section through the organ indicates the distribution of these tissues, and also that the structure enumerated above belongs essentially to the gland-sac, with the exception of the epithelial layer of the common investing membrane.

In the longitudinal section of the stem neuro-muscular bands may be seen traversing its length, and bead-like bands of granular fusiform bodies, connected at the extremities by delicate fibres, immediately underlying the cuticular epithelium. Although I was at first sight disposed to regard these as simple pigment masses, I am now inclined to consider them more intimately connected with nerve-structure. That they are different from the true pigment masses will be seen on examining a specimen from which the colour has not been discharged—the cells of these latter being much less regular in shape and much more numerous, and not united into the same longitudinal bead-like bands by the delicate fibres referred to above.

The calcareous shaft occupies only a small space in the centre of the stem, and is surrounded by a considerable thickness of nucleated connective tissue. The granular (nerve?) cells are found to be densely crowded immediately above the glandular sacculi. The foramen of the sacculus is surrounded by a strong sphincter muscle. The whole investing membrane of the *pedicellaria globifera* (head, stem, and saccular dilatation alike) is indurated on its outer surface with a large number of small, curved, calcareous spicules somewhat resembling the letter C in form, and having a slightly thickened or rounded knob-like termination at each extremity.

It occasionally happens that a *pedicellaria globifera* may be met with which is devoid of the glandular sacculi upon its stem; and no difference would at first sight be noticed between

this and the stem of one of the pedicellariæ upon which no such dilatation is known to occur. It will be found, however, on examination under the microscope, that the foramina are nevertheless present and occupy the same position as that which they would hold in one of the sac-bearing stems, and appear to be normal in every way (Pl. XII. fig. 6). I am led, therefore, to regard these as simply cases in which the glands of the sacculi are aborted from some cause or other; but how this state of things has come about I am quite unable to say.

Head of the Pedicellaria globifera.—Mucus, as previously stated, is extruded from the head or jaw-portion of the *ped. globifera*. As the anatomy of the soft parts of these organs has never been described in detail, it will be found a subject well worthy of attention on the present occasion, and will assist in the elucidation of the functions performed by these well-known and yet obscure appendages.

The structure of the calcareous framework of the head of this form of pedicellaria is familiar to most possessors of microscopes, and has been frequently figured. It is at once readily recognizable from that belonging to the *triphylla* or *tridens* form of pedicellaria. Each of the three valves or jaw-pieces of the *ped. globifera* in question is of remarkably elegant form, somewhat resembling a mandolin in shape. The basal portion is large and swollen out, presenting a convex surface outwardly and a concave one inwardly, a delicate median keel or partition separating this latter into two hollow chambers. The basal portion occupies fully one third of the height of the jaw-piece. The upper portion consists of a delicate shaft proceeding from the upper part of the basal shield in the prolongation of its median axis; it is somewhat quadrangular in section, and slightly tapers towards the upper portion; the extremity is finely pointed into a tooth-like process, which is roundly curved at a right angle to the axis of the piece and directed inwards; immediately where the curve is completed the shaft becomes somewhat constricted, and is then slightly expanded again prior to the commencement of the delicate tapering towards the tip, the expanded portion being channelled and presenting the appearance of two or more lateral lamellæ merged together to form the tip or tooth-like fang. The valves of the *pedicellaria globifera* are attached immediately to the upper part of the calcareous shaft of the stem. The whole head is invested with a very considerable development of soft parts, and presents, when closed, the appearance, so aptly described

by Valentin, of the corolla of a flower "asleep" for the night*.

Each jaw-piece is invested in a membranous sac, which gradually swells out from the tip to the base, where it presents a very inflated appearance, and merges into the general sac of the whole head, the only portion of the calcareous shaft that is visible being the fang or tooth-like process, which is left naked and protruding from the apical portion of the sac. On the upper surface of the fang the investing membrane does not lie perfectly close to the shaft; but an aperture is formed on either side, through which mucus is expelled.

No trace of the two external sac-like formations that are found in the *pedicellariæ globiferæ* of many other *Echini* is visible to superficial view in those of *Sphærechinus granularis*, the whole valve being enveloped in a single, highly inflated, membranous sac.

The valves of the pedicellaria can be opened and closed, the expansion being generally maintained until the inner surface of the valves is at right angles to the shaft, and the inner areas of the three jaws together form a plane flat surface at right angles to the stem. When in this position the fang is usually retracted, or, perhaps more correctly, hidden within the sac-like sheath (Pl. XII. figs. 3–5). At the slightest touch or irritation the jaws immediately close, and, under certain circumstances, a flow of mucus takes place from the apertures above mentioned.

Recourse must now be had to dissection and sections in various directions, to enable us to treat further on the anatomy of the organs under consideration.

On examining a longitudinal section through the pedicellaria the following tissues will be observed:—1. The fine investing membrane composed of epithelial cells; 2. A stratum with a few distributed nerve-cells; 3. The walls of a large saccular body bounded by a moderately thick layer of horizontally disposed muscular fibres; 4. Within this a widely reticulated tissue terminating in follicular gland-cells, closely aggregated and forming a layer internal to the wall of the sac, fully one third of its diameter in breadth at the median part (Pl. XIII. fig. 9). A serial range of sections, together with careful dissection of a single valve, will show that the glandular sac is divided on its upper portion by a fine partition into two chambers, both opening into the basal portion of the sac, and that these are disposed one on either

* Monographies d'Echinodermes, "Anat. du genre *Echinus*," p. 48.

side of the median line, and open at the apex of the valve on the sides of the fang as above mentioned, whence the discharge of the mucous or glairy matter secreted by the glands of the sac takes place. This sac (or double sac more accurately) is placed external to, or upon the outward side of, the central calcareous shaft of the jaw-piece. The three valves are held together by strong bands of muscles, which are attached within the hollow cavity of the basal portion, the muscular impressions being clearly perceptible on either side of the median ridge after the calcareous skeleton has been cleaned in a strong potash solution. Nerve-centres with fibres running into each valve, communicating with these muscles, may be traced in the middle of the basal portion of the head immediately above the upper extremity of the central shaft of the stem.

When the jaws or valves of the pedicellaria are opened wide, the inner margin of the base of the internal skeleton, the lower part of the free edge of the partitional keel of its basal cavity, and the extreme tip of the fang, all fall in one and the same plane, which is at right angles to the stem of the pedicellaria (Pl. XII. fig. 4). Owing to the stretching of the investing membrane a flat surface of triangular outline is thus presented, which resembles fancifully the contour of an old-fashioned three-cornered hat, the edges being somewhat loose and overturned (Pl. XII. fig. 5). In the centre of this inner surface of the expanded valves are three, small, oval-shaped cushions, approximated at their bases, and one lying upon the median keel of each of the valve-frames (Pl. XII. fig. 5, and Pl. XIII. figs. 9, 10). These organs, which are finely papillate and richly supplied with nerve-fibres (as will be found indicated in the section in Pl. XIII. fig. 12), are presumably of sensorial (*i. e.* tactile) function, and act, in all probability, as the communicators of the advent of any foreign or irritating element. When the *Echinus* is alive and at rest in a congenial environment the jaws of the pedicellaria are extended, the whole appendage swaying gently to and fro as if in search of, and in readiness for, a coming enemy.

Functions of the Pedicellariæ globiferæ.—Respecting the functions of pedicellariæ, around which subject there still remains so much doubt, I shall, in the present communication, chiefly confine my remarks to the *ped. globiferæ*—the form that has been under examination.

It would appear that one of the principal physiological actions, and that which distinguishes the present from each of the other forms of pedicellariæ, consists in the discharge of

mucus. This takes place, in the species we have been discussing (viz. *Sphærechinus granularis*), both from the head of the pedicellaria and from the sacculi of the stem.

A careful study of these organs in the living state, and a comparison of the habits of other Echinoderms, have led me to formulate the following explanation of the functions subserved by the *pedicellariæ globiferæ*; and although I am not at present able to do more than offer it as a suggestion, the facts that have laid the foundation for this conclusion are incontrovertible, whilst the argument deduced therefrom would appeal to the judgment by virtue of its reasonableness alone, even if it were unsupported by the collateral evidence of which we are in possession.

It has previously been remarked that a *Sphærechinus granularis*, when placed in fresh water, throws out a glairy mucous matter that envelops the test; and the author has seen the same discharge take place when the urchin was placed in a vessel of sea-water different from that which it had previously occupied. This discharge comes from the *pedicellariæ globiferæ*; and the opinion has already been stated that these appendages are the source to which it is entirely due.

The reason of the discharge is evidently an attempt on the part of the animal to free itself from unpleasant surroundings. The prime cause, I am inclined to think, lies in the explanation that the function of these pedicellariæ is that of removing grit, sand, dirt, or other offensive matter from the surface of the animal.

From the manner of the arrangement of parts upon the surface of a sea-urchin, it can readily be imagined that a natural tendency must exist towards the accumulation of all such substances amongst the many crevices and interstices on the body-surface, between crowded spines, ambulacral suckers, and pedicellariæ. Yet it will be found that the *Echinus* is generally wonderfully clean. In my opinion the ciliary epithelium is altogether insufficient to effect this; and the duty devolves upon the *pedicellariæ globiferæ*, the following being the manner in which the work is performed.

When the tactile cushion of the pedicellaria comes into contact with a tangible object of foreign matter, the valves close and a discharge of mucus takes place, wherewith the obnoxious object is covered. When the hold of the jaws is again relaxed the irritating substance remains entangled in a cloud of the glairy exudation, ready to be easily disengaged from the surface of the animal by a few movements of the neigh-

bouring spines, and is finally carried off by the ordinary currents of the water in which the *Echinus* lives.

A similar process may be observed with the greatest ease to be carried out by *Astropecten*; and this I have been able to verify many times by placing a specimen of the common *A. aurantiacus* in a large flat vessel, convenient for observation, and, when covered with sea-water, sprinkling some fine sand and mud over its dorsal area. In the course of a short time most of this will have been carried away by the action of the paxillæ and by the lateral papillated grooves, whilst such particles as have resisted this operation will be found enveloped in a glairy pellicle, which is gradually and by very slight motion drawn into a narrow band extending over the median line of each ray. This is then disengaged from the surface entirely, and is finally cast off by the slightest movement the starfish may make.

Without some such process it would be difficult to see how so intricate a structure as the paxillary area could be kept free from the collection of dirt and foreign matter, as the interspaces under the extended spinelets of the paxillæ form what would naturally become a receptacle for such accumulation.

Without entering further into detail on the present occasion as to the source of the mucous discharge in *Astropecten* (as I hope shortly to communicate some observations upon that point), I may say that I feel little hesitation, after a careful study of the facts above recorded, in regarding this as a strictly homologous case with that of *Sphærechinus*, and valuable for our present purpose in exemplifying the manner in which the operation is effected in that Echinoderm.

Relations, Immature Stages, and probable Origin of the Saccular Organ of the Stem.—At present I am unable to offer any satisfactory reason why there should be the two distinct sources of mucous secretion in *Sphærechinus granularis*, viz. from the sacs of the valves of the head and from the sacs upon the stem. Very probably the secretion may be of different composition from the two sets of glands. Indeed this supposition would seem to be confirmed by the difference in their histological details, as well as by the frequent (chemical?) change which is found to take place in the sacculi of the stem and the deposition of crystalline matter therein during preparation, a state of things which I have never met with in the sacs of the head of the pedicellariæ.

At first sight it may appear anomalous that such a well-marked peculiarity as the presence of the stem-sacculi should apparently be possessed only, so far as my present knowledge

goes, by *Sphærechinus granularis*. But from a study of the development of the sacculiferous *pedicellariæ globiferæ* of this species and of the structure of the ordinary form of *ped. globifera* in other *Echini*, I am inclined to consider that this is perhaps not so abnormal after all, and that the occurrence may be explained by derivation and advanced development.

Hitherto the *ped. globiferæ* of *Echini* have been simply described as possessing a globose fleshy head attached immediately to the calcareous shaft of the stem, both head and stem being alike covered with a common investing membrane. No mention has been made of the detail of the special anatomy of these parts.

The *pedicellaria globifera* of *Echinus melo* may be taken as a typical form for our present purpose. The superficial differences which at once strike the attention are the comparatively smaller size, the presence of two external and visible sacculi on the outer portion of each valve of the head, the gradual widening or expansion of the investing membrane of the stem immediately under the head, and the absence of any trace of sacculi on the stem.

A longitudinal section of this pedicellaria shows the gland-bearing sac of the valve, its muscular investment, the tactile cushion, the powerful muscles of the valves, and the attachment upon the distal extremity of the stem-rod. Each of these parts is referable to a similar structure already enumerated when treating of the section of the pedicellaria of *Sphærechinus granularis*; and for the present purpose it will not be necessary to indicate the special modifications they present in this form. The expanded portion of the investing membrane of the pedicellaria immediately underneath the head in *E. melo* demands, however, especial attention.

Within this expansion there is seen to occur immediately below the gland-sac of the valve an irregular, more or less coarsely cellular cavity or space, which is filled with mucous matter (Pl. XIII. fig. 13, *x*), and from which there appears to be an opening leading on to the inner surface of the calcareous axis of the valve-frame, by which means the mucus is probably conducted on to the under (?) side of the fang (Pl. XIII. fig. 13). I am unable to state positively at present whether the mucus is secreted originally within this chamber or not; for although a few large cells with long connective fibres may be seen within the mucous mass of the cavity, I cannot say whether they are gland-cells or not; and the doubt is also further increased by indications of what may probably turn out to be an opening between the gland-sac of the valve and the cavity in question. However this may be, there

would seem to be little doubt that the lower chamber is the homologue of the stem-sacculus in *Sphærechinus granularis*; and that such is actually the case would appear to receive demonstration when the immature stages of the *pedicellaria globifera* of. *S. granularis* are taken into consideration.

In examining a young example of *S. granularis* it will be found that, in addition to a goodly number of large and apparently fully grown sacculiferous *pedicellariæ globiferæ*, there is also a considerable proportion of the same pedicellariæ that are immature. It will be noted in these that the distance of the stem-sacculi from the valvate head is in relation to the size or stage of growth that the pedicellaria has attained; and also that, in the small examples, the size of the stem-sacculi is proportionally very much larger than in the fully grown organ, the dilatation on the stem not unfrequently exceeding the diameter of the head of the pedicellaria. Still earlier stages may be found in which the stem-sacculi are situated immediately beneath and touching the head (Pl. XIII. fig. 7), the dense white contents of the swollen sacculi being perceptible through the transparent investing membrane, and the outer surface being mottled with fine scarlet specks, whilst the contour of the stem-dilatation is globular and often exceeds in breadth that of the head (Pl. XII. fig. 7).

I have not yet been able to study these early phases of the *pedicellaria globifera* as thoroughly as is desirable; for inhe simple spirit-preparations, which are unfortunately the only ones that I possess of these stages, the delicate and very sensitive nature of the mucus-gland has defied that method of preparation, and I am in consequence unable to say any thing at present as to the internal and minute anatomy of this early form of the pedicellaria. The drawing, of which fig. 7 is a reproduction, was made from a fresh specimen, immediately after removal from the test. That this stage represents the adult form of the *pedicellaria globifera* in *E. melo*, will be at once suggested by a reference to the figures here given.

A number of small bodies are also present upon the test which appear to be a still more primitive stage of our pedicellaria, in which the organ is represented by a minute clubbed stem; but I am at present unable to say definitely whether these bodies are really the normal primitive stage of the sacculiferous *pedicellariæ globiferæ*, or whether they are simply abnormal shafts upon which only the stem-sacculi have been developed.

Admitting that the phases of growth of the pedicellariæ correspond with the stages above enumerated, the conclusion is almost unavoidable that the *pedicellaria globifera* of *Sphæ-*

rechinus granularis, with its mucus-sacculi situated midway upon the stem, is a form derived and developed from the simple and more compact condition of the organ, such as is presented in the pedicellaria of the *E. melo* type, and of which the early immature phase of the *Sphærechinus granularis*-pedicellaria, which has the mucus-sac situated immediately below the valvate head, is the representative.

In sequence to these conclusions it is perhaps not straining the argument too far to adduce it as an indication of the ancestry of the latter species from some more primitive *Echinus* type.

On the Functions of the Pedicellariæ of Echinus *in general.*—The observations above recorded and the conclusions deduced therefrom may lead not inaptly to a few remarks on the companion forms of pedicellariæ. Mr. Alexander Agassiz was, I believe, the first who by actual observation assigned the true function of any of these organs. He stated that he had watched the pellets of exuviæ being passed along the test and removed from the body of the *Echinus* by means of pedicellariæ. Unfortunately Mr. Agassiz leaves the matter without saying which of the forms of this appendage was the agent employed. I also have seen the same operation performed; and it was always the *pedicellariæ tridentes* that came into use for the purpose; indeed the most superficial examination would suggest that these alone could be employed for such a service, neither the *p. globiferæ* nor the *p. triphyllæ* having valves capable of grasping so large a body as the ejected pellets in question. On the other hand the jaws of the *p. tridentes* are admirably fitted for the purpose; and that this is the chief use of that form of pedicellaria there seems but little doubt.

The use of the *pedicellariæ globiferæ* has been indicated in the preceding pages.

Lastly we have the *ped. triphyllæ*. Unfortunately my own observations have not yet enabled me to make out their special function with any degree of certainty; but their small size, as well as their general behaviour, lead me to the decided impression that their principal use is that of seizing the smaller particles of foreign matter, which of necessity have eluded the more rigid as well as more specially organized forms above mentioned, and of casting their captures either directly away from the test or, perhaps more probably, into the mucous pellicle formed by the discharge of the *pedicellariæ globiferæ* under the circumstances previously noted. That the *ped. triphyllæ* should be used, as some writers have maintained,

for the capture of passing organisms for the purpose of food, or even for their retention until decomposition has set in and the accompanying crowds of infusoria have been produced, seems to me highly improbable when we take into account the character and behaviour of the pedicellariæ themselves and the constantly moving currents of water which the environment of the sea-urchin naturally presupposes, irrespective of any consideration as to the kind of food required by the animal. Besides this, if it were the case that these pedicellariæ were put to such a use, the jaws or head-valves would frequently be found filled with decaying matter—a circumstance which, so far as my own observations go, very seldom, if ever, happens.

EXPLANATION OF THE PLATES.

Plate XII.

Fig. 1. *Pedicellaria globifera* of *Sphærechinus granularis.* The valves of the head nearly closed. The glandular dilatation on the stem is somewhat distended; and one of the sacculi is seen disrupted by the action of very dilute spirit. × 13.

Fig. 2. Head of another example of the same form of pedicellaria, placed slightly obliquely to show the under portion. The valves are closed; and their sacculi are more ample towards the extremities than in the previous figure. × 13.

Fig. 3. The same form of pedicellaria with the valves of the head expanded. A portion of the investing membrane of the stem-dilatation has been cut away; and the internal glandular body of one of the sacculi is seen displaced. × 13.

Fig. 4. Another example in which a portion of the investing membrane has been removed, in order to show the glandular body *in situ.* The head is represented in outline, and the position of the internal calcareous skeleton of the valve is indicated. × 13.

Fig. 5. The same form of pedicellaria, expanded as in figs. 3 and 4, and seen from above, showing the position of the tactile cushions. × 13.

Fig. 6. The stem of a *pedicellaria globifera* in which the stem-sacculi are wanting, the foramina only being present. × 13.

Fig. 7. Immature stage of *pedicellaria globifera* from a young specimen of *Sphærechinus granularis.* × 24.

Fig. 8. Transverse section through one of the sacculi of the stem of *pedicellaria globifera*: × 470. *a,* epithelium; *b,* neuro-muscular layer; *c,* cellular layer; *d,* gland-cells and ducts; *e,* mucous mass.

Plate XIII.

Fig. 9. Longitudinal section through the head of the *ped. globifera* of *S. granularis,* cut slightly oblique: × 57. *a,* ephithelium; *b,* thin layer of connective tissue with isolated nerve-cells; *c,* muscular wall of the sacculus; *d,* gland-cells; *e,* muscles of the valves; *f,* muscles in connexion with the tactile cushion; *g,* the tactile cushion.

Fig. 10. Transverse section through the head of the same form of pedicellaria, cut slightly oblique: × 57. The letters have the same signification as in fig. 9.

Fig. 11. A portion of the glandular sacculus of the valve, more highly magnified: × 470. Letters same as in fig. 9.

Fig. 12. Longitudinal section of the tactile cushion: × 235. Letters same as in fig. 9.

Fig. 13. Longitudinal section of the *pedicellaria globifera* of *Echinus melo*: × 57. *a*, the glandular sac of the valve; *x*, the secondary mucus-sac.

XIII.—Gastrosaccus spiniferus, *Goës, newly described and figured.* By the Rev. T. R. R. Stebbing, M.A.

[Plate III.]

Family **Mysidæ**.

Genus Gastrosaccus, Norman.

The animal is transparent, with dendritic markings on certain parts, in particular on the last pereion- and the first and third pleon-segments, and a large patch on each side of the marsupial pouch. From the eyes to the extremity of the tail it is less than half an inch long.

Between the eyes is a short, longitudinally grooved, blunt rostrum, beneath which, and produced beyond it, is a pointed frontal process; from this to the cervical groove is about a third of the dorsal, a fourth of the lateral, length of the carapace. The large dorsal sinus of the carapace has its inner part margined with eight spines directed backwards, slightly converging, a little bent downwards at their tips; the central are the longest, the lateral very small; behind them there is a small slit in the margin, making a sort of spine-like lobe. The first four pleon-segments are nearly cylindrical, somewhat compressed at the sides; the last of the four ends dorsally in a small keeled adpressed prolongation. The fifth segment is dorsally carinate, the keel ending in a slightly upturned membranous process of small size, convex, pointed at the end; its length once and a half its breadth at the base. From the base of the pleon the body narrows rather rapidly backwards to the end of the fifth segment; from this point the sixth segment slightly widens towards the telson; it is cylindrical, nearly equal in length to each of the two segments preceding it; the second and third are the shortest.